

values are highly significantly different from the respective *Paranthropus* values. The evidence therefore supports "Telanthropus" as a refutation of the single species hypothesis of human evolution.

Notes

¹ I would like to express my sincere appreciation to Drs. L. Freedman, University of Western Australia, R. A. Johnson, University of Wisconsin, and G. P. Rightmire, State University of New York, Binghamton, for their helpful suggestions regarding statistics and J. T. Robinson, University of Wisconsin, for reading this paper in manuscript and for offering valuable suggestions and criticisms.

² In attempting to solve another taxonomic problem, Wolpoff (1969) has applied Chauvenet's technique to endocranial volume measurements of hominids from East and South Africa. After examining the statistical references cited by Wolpoff in that paper, Pilbeam (1969) concluded that this method was inappropriate for dealing with the problem, since it should only be applied to a sample from one statistical population or universe. Thus samples from different geographical regions and time periods, and distinct samples from the same region and time period, should not be pooled into one large sample. Pilbeam suggested using a *t* test for statistical comparisons.

³ A *Paranthropus M₁* from Omo has been reported (Howell 1969) but is not included in this paper since (1) it was not available to Wolpoff when he wrote his paper and (2) the specimen does not affect the relationship between "Telanthropus" and *Paranthropus* at Swartkrans.

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THE EVIDENCE FOR MULTIPLE HOMINID TAXA AT SWARTKRANS¹

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Gutgesell's review of the single species hypothesis, and the dismissal of its proposed refutation at Swartkrans, is critically examined. Most of her claims are not supported by the available evidence at Swart-

krans, nor by the morphology and variation of recognized robust australopithecines and other hominoid taxa. Her statistical results are questionable, whether or not one utilizes her procedures. With the demonstrated association of the maxilla (SK 80) with a cranium (SK 846/847) described as "Paranthropus" by both Robinson and Tobias, the only possible interpretation of the detailed morphology, the ranges of variation, and the statistical comparisons, is that SK 15, 45, and 80 are small robust australopithecines.

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Introduction

Gutgesell (AA 72:565-576) has reviewed a recent discussion of the single species hypothesis that dismissed the credibility of "Telanthropus" as a refutation of this hypothesis (Wolpoff 1968). Although her review presents little that was not in the original descriptions and discussions of the specimens concerned (Broom and Robinson 1952; Robinson 1953b), so many of her statements and claims are not supported by the currently available evidence that a detailed reply seems necessary. Beyond this, her rendition of the statistical procedures and results of both Broom and Robinson (1952:116-117) and of myself (Wolpoff 1968:487-490) is at such variance with the original versions that she is able to reach conclusions opposite to those suggested in 1968. This rendition must be critically examined.

Five cranial fragments were originally ascribed to "Telanthropus" (Oakley and Campbell 1967:87). Robinson (1967:87) has formally sunk this taxon, transferring the included material to *Homo erectus*. Two of the cranial fragments are isolated teeth: P₃ (SK 18), and P₄ (SK 43). The other three fragments are two mandibles (SK 15 and SK 45) and a maxilla (SK 80), referred to respectively by Gutgesell as "Telanthropus I, II, and III." In addition, Howell (1969b) recently demonstrated that a frontofacial fragment (SK 847) and an associated occipital fragment (SK 846) fit the maxilla (SK 80). These three fragments, therefore, belong to the same specimen. In describing SK 1587 and 1588, Brain hints that they may not be "Paranthropus" specimens because of the small size of their teeth (1967a:382). However, no formal taxonomic suggestion is

made, and because the teeth are not the smallest in the robust australopithecine sample, even excluding the "Telanthropus" specimens, they will be considered robust australopithecines.

The proximal end of a radius ascribed to "Telanthropus," which I incorrectly described as a distal end following Coon (1962:252), will not be discussed.

Hominid Phylogeny: An Evolutionary Interpretation

Gutgesell defends a position that is, I believe, without a basis in either evolutionary theory or in the evidence of robust australopithecine morphology.

One major problem is her misunderstanding of evolutionary theory and its application to phylogenetic problems in human paleontology. One encounters this quite clearly in her discussion of bipedal locomotion and its origins. She is apparently willing to accept the contention that availability at all times is crucial if tools are to be effective in defense. Yet, she completely separates the selective pressure from the resulting adaptation, concluding that culture could have only developed in a form whose hands were *already* free, citing amorphous and undefined "distinct advantages" of bipedality to a forest edge form. While on the one hand she "cannot assume that culture spontaneously appeared," not one sentence later she is assuming that bipedal locomotion did exactly that! An appreciation of selection as the major orienting factor in organic evolution resolves these difficulties. The lack of other "distinct advantages" to bipedality in forest edge forms is probably nowhere more apparent than in the observation that there are no bipedal forest edge forms. Selection could only produce an effective bipedal primate from a primate species already capable of some bipedal locomotion, as are both African apes. Neither existing African ape became completely bipedal, although both are capable of it and regularly employ it as a means of locomotion for both carrying and for defensive displays, uses which some authors suggest led to complete bipedalism in hominids. One is still left with the problem of what differentiated hominids from pongids with this locomotive ability. The availability at all times of defensive implements (cor-

rected from "weapons" by Montagu 1969) is the only hypothesis that fits all of the available facts, explaining why some primates became completely bipedal (ecotone-inhabiting forest-edge and savanna hominids), while others with the same adaptive potential and functional capabilities did not (forest-dwelling pongids). Because of its explanatory power (Wolpoff 1968:477-480 and references cited therein), an author who believes the single species hypothesis is incorrect will have to *replace* it and not simply dismiss it with unnamed "distinct advantages."

Gutgesell continues her argument with a *reductio ad absurdum*, claiming that if canine reduction resulted from disuse as *defensive* implements, "one would expect the canine of *H. sapiens* to be extremely small, if not lost entirely." She is apparently unaware that the size and incisiform morphology of hominid canines indicate what numerous ethnographic reports have detailed: hominid canines typically function as incisors in acting as *manipulative* implements (Brace 1962:347-349; Dahlberg 1964:Fig. 6; Turner and Cadien 1969). The manipulative function of canines could only become important after the slashing and cutting function was lost and the distinctive primate canine-premolar complex obliterated. Subsequent variation in canine size resulted from the same selective pressures that acted on the incisors.

Gutgesell supposes that reduction of hominid canines may not be owing to a replacement of their defensive function by tools, but rather to the absence of natural predators. As she puts it: "Since *Paranthropus* was a rather large, robust creature, there is no reason to assume that it was frequently harassed by predators any more so than the modern gorilla." The largest published size estimates for the robust australopithecines range between 150 and 200 pounds. The small surface area on the two Swartkrans femur heads, indicating that not much weight was transmitted through this joint, casts even these estimates in doubt. On the other hand male gorillas who act in the defensive capacity (Schaller 1963) range between 300 and 400 pounds (Napier and Napier 1967:161) and do not live on either forest edges or savannas. The necessity of maintaining an effective means of defense in primates with a body size range of 100-200 pounds living in

these areas is illustrated by the fact that the giant Villafranchian baboon males, many larger than gorillas (L.S.B. Leakey 1960:428), were equipped with canines proportionally as large as those in much smaller extant baboon males.

Pointing out that I place the robust australopithecines on the lineage leading to *Homo erectus*, Gutgesell asks for an explanation of her claim that robust australopithecine canines are smaller than those of *Homo erectus*, even though the latter has been using tools for a longer period of time. I believe that one should first determine whether robust australopithecine canines are, in actuality, smaller than those of *Homo erectus*. Using australopithecine data collected by C. L. Brace, and data for all of the known *Homo erectus* specimens (Wolpoff 1970), areas (length times breadth) were calculated for all mandibular and maxillary canines as a measure of size (measurements given in mm²). In mandibular canines, the *Homo erectus* average area is 77 for a sample size of 16 (range 62-98, *CV* = 14.6). For 17 specimens the robust australopithecine mean is 68 (range 48-96, *CV* = 16.4), and 12 gracile australopithecines averaged 88 (range 73-104, *CV* = 11.7). In the maxilla 10 *Homo erectus* canines average 97 (range 83-113, *CV* = 11.1). The australopithecine means are closer, 20 robust teeth averaging 87 (range 68-111, *CV* = 13.3), and 10 gracile teeth average 90 (range 73-104, *CV* = 11.1). Differences between average canine sizes among extant populations are regularly more extensive (Wolpoff 1970: Tables 22, 27). In order to discover if the fossil hominid differences could be the result of anything more than small sample size, the *t* test was used to determine the significance of the differences. The necessary conditions are met for this test. Specifically, the question of whether *either* australopithecine group has canine areas significantly different from *Homo erectus* was tested. The results for both mandibular and maxillary samples were that *neither* gracile nor robust australopithecines have canines significantly different in size from those of *Homo erectus* on the one percent level. Using a criterion of rejecting the hypothesis when the probability of error exceeds 1/2*n*, a level of 1.5% is indicated. There are no significant differences on this level either! In other words, the canine size

differences Gutgesell wants accounted for do not, in reality, exist at a level of significance that would demonstrate that they could not be due to the small size of the samples.

The archeological claims that Gutgesell makes are also not supported by the available evidence. In discussing the absence of tools associated with the earliest hominids, Gutgesell clearly has Oldowan pebble tools in mind. It is difficult to imagine the effective use of these split pebbles as a means of defense, although they were probably of great aid in the cutting and dismembering necessitated by scavenging activity. It is far more likely that the earliest useful defensive implements took the form of clubs. The clubbing of baboon crania has been established at the earliest australopithecine sites in South Africa. At Makapansgat there are both baboon crania with double depressed fractures and the distal femur ends that probably acted as clubs, while at both Taung and the Lower Breccia at Sterkfontein the same distinctive baboon crania with double depressed fractures have been found (Tobias 1967b). In a report concerned with recent excavations at Sterkfontein and the reevaluation of previous discoveries, Tobias and Hughes (1969) identify the site of the discovery of STS 5—in the *middle breccia*. The question of whether *any* of the australopithecines came from the Lower Breccia was raised. Thus, there is a *clear* association of australopithecines and tools at Sterkfontein. There is some additional evidence available concerned with the dating of the Transvaal caves. Cooke (1967:180–181) correlates the oldest Vaal gravels with the Sterkfontein faunal span, and Maglio (1970) equates the beginning of the Vaal River sequence (oldest gravels) with Kanam east on the basis of an Africa-wide Elephantidae stratigraphy. Based on associations with other sites, he suggests dates of four million years for Kanam and the oldest Vaal gravels (hence the Sterkfontein faunal span). In sum, the Transvaal cave sequence may be significantly older than previously thought. In any event at its base is a site with clear association of australopithecines and stone tools. Tool use for the earliest South African australopithecines is thus indicated.

The earliest sites with actual dates containing both stone tools and australopithecines are in East Africa. Both stone and

bone tools extend to the bottom of Bed I, Olduvai Gorge (M. Leakey 1967). The east shore of Lake Rudolf has yielded both australopithecines and stone tools older than 2.6 million years (R. Leakey, personal communication). Another site with such an association, Kanam, is apparently earlier (Bishop 1967a:44, 1967b:87), probably as early as, if not earlier than, the Omo deposits (L.S.B. Leakey 1967:9–10), which have been dated over a range of from less than two to more than four million years (Howell 1969a:1234). The mandibular fragment coming from the same deposit as the Oldowan tools is characterized by a deep and robust body with small anterior teeth and large premolars, features that have led L.S.B. Leakey to suggest: “it becomes highly probable that the Kanam mandible represents, in fact, a female of *Zinjanthropus*” (1961:xi–xii). In other words, an australopithecine (if not a robust australopithecine) associated with an Oldowan industry predates the Olduvai deposits, and possibly predates four million years. The available evidence, therefore, does not support Gutgesell’s suppositions, but is rather in line with the predictions of the single species hypothesis.

Most of her other claims, suggesting that robust australopithecines and *Homo erectus* were synchronic, were discussed in the original paper (Wolpoff 1968:477–478). The proposed association of “*Paranthropus*” and *Homo erectus* in Java concerns the third “*Meganthropus*” mandible, reported by Marks (1953). Robinson claims that this specimen comes from “the later Kabuh conglomerate of the Sangiran dome” (1962:127). If this were true, it would overlie some of the *Homo erectus* specimens, and thus conclusively demonstrate that this taxon was allochronic with robust australopithecines. However, the mandible was not found *in situ*. It was picked up on the surface by a native. When Marks returned to the site, he identified a strongly cemented conglomerate it *may* have weathered out of (Marks 1953:26). This conglomerate contained “numerous fragments of water worn vertebrate bones and teeth . . . as well as well-sorted pebbles” (1953:26). Obviously deposited by moving water, the mandible could have washed out of an *earlier* deposit and subsequently been redeposited. Finally,

even if the provenience were unquestionable, the conglomerate "forms a distinct level as it overlies and in turn is being overlain by soft black clays of the Putjangan beds" (1953:26). The Putjangan beds *underlie* the Kabuh conglomerate, predate a tektite date of 750,000, and are widely believed to be of Villafranchian age. Marks's discovery, then, merely verifies the fact that both australopithecines and *Homo erectus* can be found in Javanese deposits of Villafranchian age. Given the length of the Villafranchian and the thickness of the Putjangan beds, this verification does not prove the hominids synchronic.

Problems in evolutionary interpretation extend throughout the paper and are far too numerous to document completely. At one point, for instance, SK 15 is described as "an intermediate stage of evolution between *Paranthropus* and *H. sapiens*." Does Gutgesell then believe that "*Paranthropus*" evolved into *Homo sapiens* via "*Telanthropus*"? This hardly seems in line with the intent of her paper, although it is the only apparent interpretation of the statement.

The most serious results of these problems, however, stem from her treatment of fossil samples. She contends that because the robust australopithecines at Swartkrans were all found in the same cave, they can be treated as a *local biological population*. Suggestions of the time span represented at Swartkrans have ranged from 20,000 to a half million years. Even if one assumes a time span *far less* than any worker would accept, say several centuries, Gutgesell's contention is simply incorrect. In order for it to be correct, the deposit would have to represent something like a campsite completely buried in an instant and deposited in the cave. In terms of *actual genetic relationship* some specimens (for instance, the very robust SK 845) may be more closely related to individuals many thousands of miles away (for instance, Olduvai hominid 5) than they are to specimens only inches away in the same deposit. Each specimen at Swartkrans may be a member of a distinct local breeding population; we have no justification for assuming they are not. What unifies these specimens, and allows us to treat them in a single group, is their membership in the same *species*. A species is, after all, a population presumably made up of distinct small-

er local populations (Simpson 1963:7-8). There is no possible way for the paleontologist to distinguish the local populations; the smallest taxonomic unit one can deal with is the species itself (Simpson 1961:175-176). There is absolutely no basis to Gutgesell's claim: "An estimated population range of variation based on the observed range of variation at Swartkrans should give a reasonable indication of the local *Paranthropus* population." One simply does not have sufficient control of the variables to distinguish local populations within the species. Robinson has recently discussed this point quite clearly (1967:70-75).

By excluding robust australopithecines not from Swartkrans, Gutgesell is limiting her comparisons to a set of specimens that is by itself neither representative of a species, a subspecies, a local population, a deme, nor any other taxonomically meaningful group (Simpson 1963:1-4). Following Robinson's discussion of Olduvai hominid 5 (1968), the smallest meaningful taxon to which the Swartkrans specimens belong is made up of robust australopithecines from Swartkrans, Kromdraai, Natron, Olduvai Gorge, Java, and probably the Omo beds. By claiming that the Swartkrans specimens are representative of a taxon and then limiting comparisons to members of that taxon at Swartkrans, Gutgesell has been able to demonstrate numerous distinctions between the "*Telanthropus*" specimens and the taxon at Swartkrans that, it turns out, do *not* distinguish these same "*Telanthropus*" specimens from other members of *the same taxon* that happened not to be found at Swartkrans.

In checking the claims made by Gutgesell, I have approached comparisons of the "*Telanthropus*" specimens with the robust australopithecines by first examining the observed range of variation of each feature within both samples *regardless* of the claims present in the literature about this range. There have been a number of interesting results that should surprise the reader as much as they have me. Ranges of variation in those features that successfully distinguish the two groups are examined in gracile australopithecines, when possible, and in some extant hominoids: the African apes and man. In this way, the phyletic valence of these features in the most closely related primates can be determined and a basis estab-

lished for determining the *expected* range of variation for these features in robust australopithecines.

Swartkrans Stratigraphy

Gutgesell's interpretation of the stratigraphy at Swartkrans, as well as her rendition of this author's interpretation, is incorrect. Brain's recent reconstruction of the Swartkrans cave (1967a:383) indicates that the osteological material fell into the cave down a shaft fifty to sixty feet deep after lying exposed in a rock shelter for a period of time. The rock shelter at the surface was probably fairly extensive.

When the bones were eventually washed into the outer cave proper, they fell along a slope (Brain 1958:Fig. 70, 71; Wolpoff 1968: Fig. 1). The outer pink breccia appears to be vertically unstratified (Brain 1958:80). However, there is a marked horizontal grading trend, involving particle size differences, as one passes away from the position of the shaft (1958:80; 1967a:382-383).

There are four reasons why neither vertical nor horizontal relations of specimens in the pink breccia deposit are *necessarily* in-

dicative of temporal relation: (1) The existence of a talus slope, recognized by Gutgesell, means that as bones fell in, they could have lodged *anywhere along the slope*. On the one hand, two specimens falling down the fifty foot shaft could lodge on opposite ends of the slope (possibly separated by the entire vertical length of the pink breccia deposit). On the other hand, specimens falling in separated by a long period of time could lodge at the same vertical level, and in close horizontal proximity, along much of the slope. It is significant that SK 15, 45, and 80 all come from the upper two-thirds of the deposit (Robinson 1953b:449). (2) There was a differential length of exposure in the Swartkrans rock shelter before deposition in the actual cave (Brain 1967a:383). Specimens that died at very different times could have entered the cave at the same time. That the bones could have remained in the shelter for a considerable period of time is indicated by the "severe weathering" of some specimens that presumably occurred in what was "likely . . . a fairly extensive rock shelter" (1967a:382-383). (3) The presence of horizontal, but not vertical, grading in the particle size of foreign material indicates a

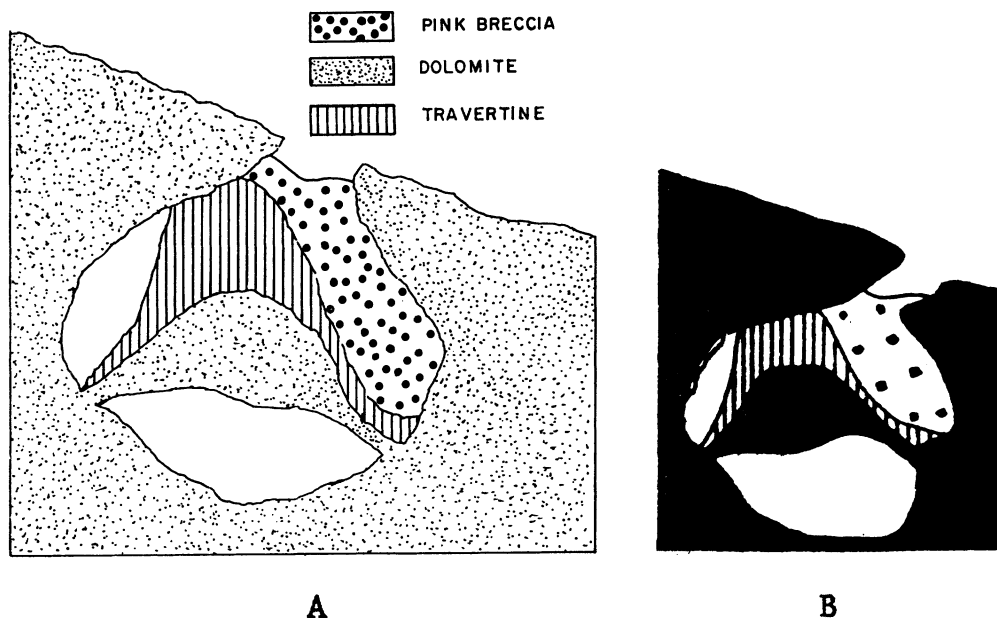


FIGURE 1. Comparison of Figure 1 from Wolpoff (1968:483), A, with Stage 5 of Figure 70/71 from Brain (1958:86), B.

differential deposition down the slope. I have already suggested a similar analysis of the organic material (1968:482). Brain (1967b:291) has pointed out that such differential transport is common. (4) After formation of the pink breccia, the entire pink breccia deposit was shifted and warped with the collapse of the lower chamber, opening up the inner cave where the brown breccia was formed (Brain 1967b:286-288; 1958:86-87). One robust mandible, SK 23, came from the base of the brown breccia of the inner cave. Several authors have suggested the possibility that it came from a block of outer cave pink breccia embedded within the brown (Oakley and Campbell 1967:87-88; Brain 1958:87-88). The fact that the mandible has undergone distortion (Broom and Robinson 1952:19) supports this suggestion. The distortion probably occurred when the lower cave collapsed, first opening the passage to the inner cave.

Clearly, many of Gutgesell's incorrect interpretations result from an attempt to use vertical distance alone as a measure of temporal separation in a sloping deposit (a talus slope is forty-five degrees or more, Butzer 1964:196) with horizontal particle size gradation and differentials in the time span between death and deposition. In a deposit such as this, with derived material and a complete absence of vertical stratigraphy in the inorganic material, the temporal relations of specimens are ambiguous.

Other errors, however, seem to stem from a misreading of sources. For instance, Gutgesell states that the pink breccia "showed only slight traces of stratification" and utilizes Brain (1958) as a reference. Brain (1958:80) is explicit in his statement "the pink breccia appears to be unstratified." Figure 1 compares the figure from Wolpoff (1968:483) entitled "stage in the evolution of the Swartkrans cave prior to the calcification of the pink breccia deposit" with "Stage 5" of Figure 70 (and 71) from Brain (1958:86) described as ". . . this, when calcified, will form the pink breccia deposit." Readers may judge for themselves whether "Wolpoff's Figure 1 . . . is so different from Brain's original drawings that one's interpretation of the cave deposition is altered significantly."

Apparently, Gutgesell has confused *uniformity* and *continuity* with reference to

geological deposits. In one paragraph, she uses the lack of nonconformities to indicate no time gaps and to show that continuous deposition occurred. However, she concludes from this "the outer cave deposit was uniform." She goes on to claim that uniformity is "a concept unrelated to the number of taxa involved." This confusion may underlie the logical contradictions in her subsequent discussion.

Robinson based his claim of uniformity in the pink breccia on the contention

There is no evidence of stratification of the fossils. . . Australopithecine remains have been recovered from the surface layers as well as the deepest ones and the characters of the recovered material are very uniform. . . The time lapse between the bottom and the surface was clearly not great enough for it to be detectable in the contained fauna [1953b:448-449].

He then goes on, for the bulk of the paper, to support a claim that certain of the australopithecine remains found in the upper two-thirds of the deposit were, in fact, different from the others. If this were true, it would follow that the fauna at the base of the deposit (without "Telanthropus") was detectably different from the fauna at the top (presumably with "Telanthropus").

In brief, uniformity is made a condition necessary in demonstrating co-occurrence. However, Robinson believes that in the outer pink breccia "specimens from the surface levels must be younger than those in the deepest levels" (1953b:449). Therefore, if "Paranthropus" is a different taxon than "Telanthropus," and if the two occur together at only a certain level of the cave, it must follow that *the deposit is not uniform*. Yet, Gutgesell defends the conclusion of uniformity and sympatry as "logical and legitimate."

She then goes on to interpret a discussion of Robinson's inconsistency as a claim on my part that "sympatric hominid genera in a deposit is an impossibility," when I clearly stated both at the end of the section concerned with stratigraphy (1968:477) and at the conclusion to the entire paper (1968:490) that the stratigraphic evidence is ambiguous.

Nondental Morphology

In writing the original paper, I attempted

to choose for detailed analysis those features and characteristics that had apparent phylogenetic and/or adaptive significance. As Robinson describes the problem:

It seems improbable that one should find oneself in a position where it is almost impossible to distinguish between a baboon and a man, and should one find oneself in so parlous a condition it is unlikely that one could turn to the mylohyoid groove to extricate oneself [1953b:470].

Thus, statements about features of similar import were assumed correct, and the major part of the discussion centered upon those features to which one presumably could turn. Weighting the evidence in this manner, however, is apparently disagreeable to Gutgesell. Therefore, it is of considerable interest to examine the characteristics that she considers crucial in the analysis of the mandibular and maxillary specimens.

The Mandibles. In examining the factual basis for the statements Gutgesell makes in comparing SK 15 and SK 45 with the "Paranthropus" sample, I have found that the majority of these statements are incorrect. Gutgesell states that the bicondylar breadth of SK 15 exceeds the maximum mandibular length measured in the sagittal plane. I have calculated the ratio of the former to the latter to be 105 (from Robinson 1953b:463). The opposite is *not* the case in "Paranthropus." The ratio calculated for SK 12 is 106 (from Broom and Robinson 1950b:302:Plate 1), for the Natron mandible the ratio is 108 (from Tobias 1965:27, Fig. 4), for SK 34 it is about 120, and for von Koenigswald's most recent reconstruction of the "Meganthropus" mandible, the calculated ratio is 127 (from Brace, Nelson, and Korn 1970: Fig. 23). For only one mandible, SK 23, is the ratio less than 100 (Broom and Robinson 1952: Plate 6, Fig. 21). In this case it is 92, but the two sides of the mandible have been crushed together toward the midline (Broom and Robinson 1952:19) increasing the length, decreasing the bicondylar breadth, and in both ways lowering the observed ratio. Compared with the undistorted "Paranthropus" mandibles, SK 15 has the *lowest* ratio.

Gutgesell believes the greater height of the ramus measured at the condyle above the tooth row in "Paranthropus" mandibles must

mean the associated crania had smaller cranial capacities. At one point she refers to the "probability" that "Telanthropus" had a larger cranial capacity, and derides me for ignoring it. Her hypothesis, quoted from Robinson (1953b:498), can easily be tested. One need only find the correlation of condyle height above the tooth row with cranial capacity. This author calculated such correlations for three groups, based on published measurements: Ninth Dynasty Egyptians (Woo 1930), Badarians (Stoessiger 1927), and Hylam Chinese (Harrower 1928a, 1928b). The correlations were, respectively, 0.21 ($n=46$), 0.27 ($n=38$), and 0.29 ($n=38$). Not one of these correlations is significantly different from zero, even on the five percent level. With no correlation found, the ramus height-cranial capacity hypothesis can be dismissed.

In SK 15, the minimum internal distance between halves of the mandible at M_1 is *not* two times the corpus width. For this to be true, the ratio of the former to the latter would have to be 200. Robinson (1966:957) is explicit in stating that this ratio be taken at the P_4/M_1 juncture, claiming "I have always used it in the same way." On both the unreconstructed cast and the picture of SK 15 (Broom and Robinson 1952: Plate 8, Fig. 27), the ratio is 118. The ratio for Robinson's 1953 reconstruction of SK 15 (1953b: Fig. 7) is 142, but for Broom and Robinson's 1952 reconstruction (1952:Fig. 57) it is 85!

The U-shaped internal mandibular contour is characteristic of a number of australopithecine specimens and is not unique to SK 15 alone. Robinson (1966:Fig. 1) has explicitly pictured the difference between this internal contour, and the V contour presumably "reflecting an early stage in human evolution." Among the robust australopithecines, SK 12, SK 34, and SK 74a (Broom and Robinson 1952:Fig. 23) all have U shaped internal contours, while SK 23 (crushed toward the midline), Natron, and Omo L7-125 (Howell 1969a:Fig. 10) have V-shaped contours. Contours of Omo mandibles from localities 58 and 18 (Arambourg and Coppens 1968:Fig. 1) are intermediate. Gracile australopithecines show similar variation. MLD 18 (Dart 1962:Fig. 3) has a U-shaped contour, while V shapes occur in STS 52 and less so in STS 36. Internal mandibular contours do not distinguish SK 15 from other specimens at

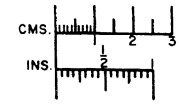


FIGURE 2. (a) STS 36 (positioning of fragments approximate), (b) SK 23, (c) SK 34, (d) SK 12, and (e) SK 74A.

TABLE 1. CONDYLE HEIGHT ABOVE INFERIOR MANDIBULAR MARGIN (mm)

Taxon	Mean (M)	Range	D	N	CV	D/M	D/SSD
<i>Pan gorilla</i>	106	79-133	54	39	14	51	73
<i>P. troglodytes</i>	63	24- 87	63	52	15	100	126
<i>Homo sapiens</i>	55	39- 79	40	425	14	73	104

Swartkrans, let alone from other robust australopithecines.

Gutgesell claims "the front of the 'Telanthropus' symphysis most closely resembles that of the Heidelberg mandible," and attributes this statement to Broom and Robinson (1952). In doing so, she misquotes these authors who actually refer to the entire symphyseal region, not just the front, in comparing SK 15 with the Mauer mandible (1952:110). In the same monograph, the authors state the symphysis of SK 6 resembles the Mauer mandible (1952:2); the symphysis of SK 12 is "essentially similar" to that of Mauer (1952:5); the symphysis of SK 34 "agrees more closely with that of Heidelberg man than with that of any of the anthropoids or that of modern man" (1952:18); the lower anterior symphyseal portion of SK 74a has an upper part of the chin "which in structure is almost human" (1952:22). Comparison of the symphyseal cross-sections of SK 15 (Fig. 56) and SK 34 (Fig. 16) demonstrates a minute identity in proportions. Thus, it seems as though the symphysis of SK 15 holds nothing of distinction when compared with other specimens at Swartkrans. This point was raised and settled by Dart some years ago (1955:80-84) in an article whose relevance Gutgesell specifically rejects on the basis that "most of its statements are not particularly relevant and do not invalidate the distinctions between 'Telanthropus' and *Paranthropus* based on size, proportion, and morphological structure."

While the remainder of the comparisons made by Gutgesell—of the "Telanthropus" mandibles with the robust australopithecines—are not factually incorrect, almost without exception they suggest distinctions on the basis of characteristics and features that show extensive variation *within* the most closely related taxa of both apes and men. In other words, the remaining criteria used to distinguish these mandibles are *more variable* in related hominoid taxa than they are

in the robust australopithecines, *even including* SK 15 and SK 45. Using a term suggested by Robinson, these features have a low phyletic valence.

Heights of the corpus and the ramus illustrate this point quite well. Gutgesell points out that ramus heights at Swartkrans range to almost double SK 15. Condyle height varies from 55 mm (SK 15) to 105 mm (SK 34). The range may be expressed as a ratio to five times the standard deviation as a measure of relative variability. For the robust australopithecine sample, including SK 15, this ratio is 56 ($n = 5$). Table 1 gives data for chimpanzees, gorillas, and a sample of *Homo sapiens*. The anthropoids were measured by myself from collections at the Field Museum in Chicago, the American Museum of Natural History, and Case Western Reserve University (Hamann-Todd). The *Homo sapiens* sample includes specimens from the Hamann-Todd collection measured by myself, and additional specimens representing a world wide distribution published by Harrower (1928b), Hooke (1926), Stoessiger (1927), Woo (1930), Chappel (1927), Cameron (1923), Jelinek (1964), Galloway (1959), Jorgensen (1953), and Murrill (1968). The absolute range of variation (D) is greater in both ape taxa. The relative range of variation (D/M) is probably a better way of comparing ranges when means differ greatly. The relative range for the robust australopithecine sample with SK 15 is 58 ($n = 5$). This index is greatly exceeded by both chimpanzees and modern man, and in turn only slightly exceeds gorillas. The relative variability (D/SSD) of the robust australopithecine sample, *with* SK 15, is much less than the three hominoid taxa.

Corpus height of the mandible is generally measured at M_1/M_2 . Table 2 gives data for this measurement in robust and gracile australopithecines, *Homo sapiens*, and the African apes. Sources are the same as for ramus height. The robust australopithecine

TABLE 2. CORPUS HEIGHT OF MANDIBLE AT M1/M2 (mm)

Taxon	Mean (M)	Range	D	N	CV	D/M
Australopithecines						
robust	35	27-42	15	8	13	42
gracile	32	24-38	14	6	15	43
<i>Homo sapiens</i>	26	14-39	25	385	16	95
<i>Pan gorilla</i>	38	27-47	20	37	14	53
<i>P. troglodytes</i>	28	13-38	25	35	14	91

sample, which includes both SK 15 and SK 45, is almost identical to the gracile sample in mean, range, and both absolute and relative variability.

Clearly, including SK 15 and SK 45 in the robust australopithecine sample is not "abhorrent biologically" as Gutgesell suggests. The resulting observed range of this sample is significantly less than the ranges observed in extant hominoid taxa. Table 2 indicates how great this difference is for corpus height. The absolute ranges (D) and the relative ranges (D/M) in extant hominoid taxa are far in excess of both australopithecine groups, although the variability (represented by the coefficient of variation, CV) in all groups is almost identical. As was true for condyle height, SK 15 and SK 45 have corpus heights of about what one would expect in small robust australopithecines. Comparison of both australopithecine groups with other taxa indicates that the expected range of variation still significantly exceeds the observed range.

The ramus breadth of SK 15 is of some interest. As Gutgesell appreciates, it is a very broad ramus, almost approaching the other robust australopithecines. Scott has suggested the ratio of the summed length of the three mandibular molars to the breadth of the ramus as a measure of mastication power (1957:218-221): ramus breadth acts as a measure of masseter size, and the summed tooth length measures the area over which the masseter acts. The lower the ratio,

the more the available power. He gives 62 and 61 as values for the chimpanzee and the gorilla and indicates extant group averages from 87 to 107. SK 15 and SK 23 have identical ratios of 84. Robust australopithecines range from 76 (SK 12) to 95 (Natron), while gracile specimens range from 75 (STS 7) to 99 (MLD 40). The mean ratios for these two groups, 85 and 87, are almost identical. Therefore, SK 15 has the ramus breadth one would expect in order to exert the same amount of power in mastication that other australopithecines—both robust and gracile—normally exert.

The choice of the minimum internal diameter to corpus breadth ratio as a distinguishing criterion is successful in that it does distinguish SK 15 from the other robust australopithecine mandibles. However, this ratio is subject to fantastic variation in hominoid taxa. Table 3 gives the statistics for this ratio in the African apes and *Homo sapiens*. Coefficients of variation range from 28 to 64! Even if we accept the narrowest reconstruction of SK 15, with a ratio of 142, the robust australopithecine range, expressed as a ratio with the mean (D/M), is 116. This is quite close to the other taxa and is less than the relative range for chimpanzees.

Gutgesell claims that the mylohyoid groove—foramen complex of SK 15 "is more nearly typical of modern hominines than is that of *Paranthropus*." She is quoting Robinson (1953b:469). One's insight into Robinson's reasoning is illuminated with a more

TABLE 3. RATIO OF MINIMUM INTERNAL DIAMETER TO CORPUS BREADTH OF MANDIBLE AT P4/M1

Taxon	Mean	Range	D	N	CV	D/M
<i>Homo sapiens</i>	181	80-268	188	37	64	104
<i>Pan troglodytes</i>	148	63-245	182	48	45	123
<i>P. gorilla</i>	79	28-115	87	29	23	110

complete rendition of this paragraph. After concluding that the complexes of *both* SK 15 and "Paranthropus" are "of the so-called 'human type,'" he goes on to conclude that the complex in SK 15 is somehow "more nearly typical of modern euhominids." The fact that SK 15 has a complex occurring in modern hominids with greater frequency than the complex associated with other Swartkrans specimens does not mean SK 15 is necessarily a more modern type than these other specimens.

Size of the retromolar fossa, the definition of *crista endocondyloidea*, *crista endocoronoidea*, *planum triangularis*, and the genio-glossal fossa are subject to considerable variation in hominoids, extinct and extant. In extant taxa, such variation is immediately apparent from even a brief perusal of existing skeletal collections. Several authors have recorded the extensive variation of the genio-glossal fossa in extant groups (Galloway 1959:Fig. 13; Dart 1955:Fig. 3; Weidenreich 1945:Fig. 12). Arambourg illustrates similar variation in *Homo erectus* (1953:Figs. 34, 46, 47, and 55). Variation among the australopithecines is clearly comparable, ranging from the extreme in the Omo mandible from locality 18 (Arambourg and Coppens 1968:Fig. 2) to the slight hollow present in SK 74a (Broom and Robinson 1950b:299, Fig. 4). Robinson (1953a:25-30, Fig. 6) described a range of variation in this feature for robust australopithecines more than sufficient to encompass SK 15. Although he chose to represent the gracile end of the range at Swartkrans with a six-year-old specimen (SK 61), SK 74a could have been used. Thus, the range suggested is valid.

The definition of the surfaces and buttresses on the inner surface of the mandibular ramus connected with attachments of *m. temporalis* ranges from pronounced to absent in gorillas, chimpanzees, and modern humans in the Hamann-Todd collection. Galloway records this much variation at Bambandyanalo (1959:39-44), and Arambourg illustrates an equivalent range among specimens of *Homo erectus* (1963:Figs. 47, 48, and 55), building upon the earlier work of Weidenreich (1936). Given this much variation in *Homo sapiens*, *Homo erectus*, chimpanzees, and gorillas, it is surely not surprising to find it among ro-

bust australopithecines.

The position of the endocoronoid buttress illustrates this extensive variation in a quantifiable manner. Gutgesell claims that the buttress runs "anterior to the tip of the coronoid," which in turn curves backwards. Even this initial statement is not clearly correct; an internal drawing of SK 34 (Broom and Robinson 1952:Fig. 15) appears to show a buttress approaching the tip of the coronoid process, and the left ramus of the Natron mandible, as preserved, has a coronoid process that clearly does not curve posteriorly. This author examined a large number of anthropoid specimens in the Hamann-Todd collection and can state that the buttress runs to the tip of the coronoid process (Gutgesell's "*Homo sapiens* condition") in about ten percent of the gorillas and thirty percent of the chimpanzees. Conversely, the condition described for "Paranthropus" was found in about eight percent of the *Homo sapiens* specimens. Arambourg illustrates the so-called "Paranthropus" condition for a *Homo erectus* mandible: Ternifine 3 (1963:Fig. 55 and Plate 5, Fig. 2). Finally, there is nothing to indicate that SK 15 does *not* have the coronoid morphology described (albeit incorrectly) as invariant in "Paranthropus"; the area of muscle attachment is not preserved. Indeed, with the suggestion of mastication power in SK 15 equivalent to that in SK 23, one would expect to find a similar array of features resulting from muscle pull. It is noteworthy that SK 23 has the most pronounced anterior buttress at Swartkrans (Broom and Robinson 1952:Fig. 17).

If these mandibles are legitimately members of the robust australopithecine taxon, one would expect to find continuous variation, in features of sufficient sample size, between these and other mandibles. Such continuity has already been demonstrated for a number of characteristics. To these we may add the general size of the mandible. SK 74a closely approaches SK 15 in most size dimensions. The major exception is the thicker symphyseal region in the former. However, the length of the tooth row from M_3 to I_1 projected in the median sagittal plane, 62 mm, is identical to that of the SK 15 reconstruction proposed by Robinson (1953b). Reconstructing the broken left side of SK 74a symmetrically with the right, and matching internal contours of actual left and recon-

structed left, one can make the following comparisons between the SK 74a reconstruction and the SK 15 reconstruction: external breadth at P_1/M_1 : 53 mm and 55 mm; external breadth at M_2/M_3 : 78 mm and 76 mm; internal breadth at $M_1/2$: 24 mm and 20 mm. These comparisons show that SK 74 is a smaller mandible in all aspects except corpus thickness.

Given that many of the features discussed in this section are components of the masticatory complex, one can only conclude that in terms of their detailed morphology, proportions, and total morphological pattern, SK 15 and SK 45 appear *typical of what one would expect* in small mandibles of robust australopithecines.

The Maxilla. In reviewing the section comparing the "Telanthropus" maxilla (SK 80) with those of robust australopithecines, one finds the same type of problems that were encountered in Gutgesell's discussion of the mandibles; her claims are either not supported by the available evidence or at best utilize variations that regularly occur *within* hominoid species to distinguish genera. For instance, according to Gutgesell, the length and breadth dimensions of the SK 80 canine root are smaller than those of "Paranthropus." In 1956, Robinson published the dimensions of six robust australopithecine maxillary canine roots (1956:43). Of these, *three* are smaller than SK 80 in *both* length and breadth. The root length of the SK 80 canine (19.8 mm) is also reported to be less than for "Paranthropus." For the robust australopithecines, however, this measurement is possible on only *one root!* The root length in this specimen (SK 4) is 26.6 mm (Robinson 1956:43), so the difference between the two roots concerned is 6.8 mm. In other words, the single robust australopithecine root, associated with the second largest crown in the series of six, is about thirty percent longer than the SK 80 canine root. In *Homo sapiens*, canine roots regularly vary from 6 mm to 22 mm (Taylor 1969:Figs. 2-6). This represents a range of 16 mm, almost two and one-half times the range at Swartkrans. Root length ranges from 10 mm to 24 mm in Lapps (Selmer-Olsen 1949:117), and from 14 mm to 23 mm in Australian aborigines (Campbell 1925:17), to cite data from more localized groups representing the

extremes in crown diameters. Differences in anthropoid maxillary canine root lengths are even more extensive than those indicated for *Homo sapiens*. The two Swartkrans roots, SK 4 and SK 80, represent far less variation than regularly occurs in hominoid taxa.

Gutgesell distinguishes the palate forms on the basis of vaulting, claiming that the anterior vaulting of SK 80 allows the palate to run parallel to the alveolar margin, while in the Swartkrans robust australopithecines the anterior is very shallow and the palate at an angle with the alveolar margin. Robinson (1960:457) has been explicit in defining this characteristic, stating that in "Paranthropus" the palate always shows "an appreciable difference between the anterior and posterior depths." SK 47, although an adolescent, illustrates this condition quite clearly. The ratio of median palate anterior depth (at the incisive fossa) to median palate posterior depth (at M^2/M^3) is 38, measured on the cast. The same ratio for SK 48 is 53. A relatively higher anterior would result in a higher ratio. For the reconstructed Peking skull, the ratio is about 56. The mean ratio for forty-five *Homo sapiens* specimens is 65, exactly the same as for twenty-five chimpanzees. The mean for thirty gorillas is 55. Ranges in all three taxa, measured and calculated by myself, extend from less than 30 (15 for gorillas) to 100. MLD 9 has a ratio of 57, and STS 5 is 70. With this background, the fact that Olduvai hominid 5 has a ratio of 87 is illuminating. Only twenty percent of the *Homo sapiens* sample is higher. The range among robust australopithecines (38-87) *without* SK 80 is comparable to the other hominoid taxa. By every indication SK 80 falls within this range. Therefore, the palate is not more parallel to the occlusal plane than in other robust australopithecines. Finally, even the statement that the Swartkrans specimens are "very shallow anteriorly," is not true of all individuals, Gutgesell's Figure 1 to the contrary notwithstanding. Robinson (1960:457) suggests measuring anterior depth at the incisive fossa. The anterior depth measurement for SK 47 is 3 mm, slightly greater than the *Homo sapiens* minimum. However, the anterior depth of SK 48, 8.5 mm, is *greater* than over one half the *Homo sapiens* sample.

The morphology of the SK 80 palate pre-

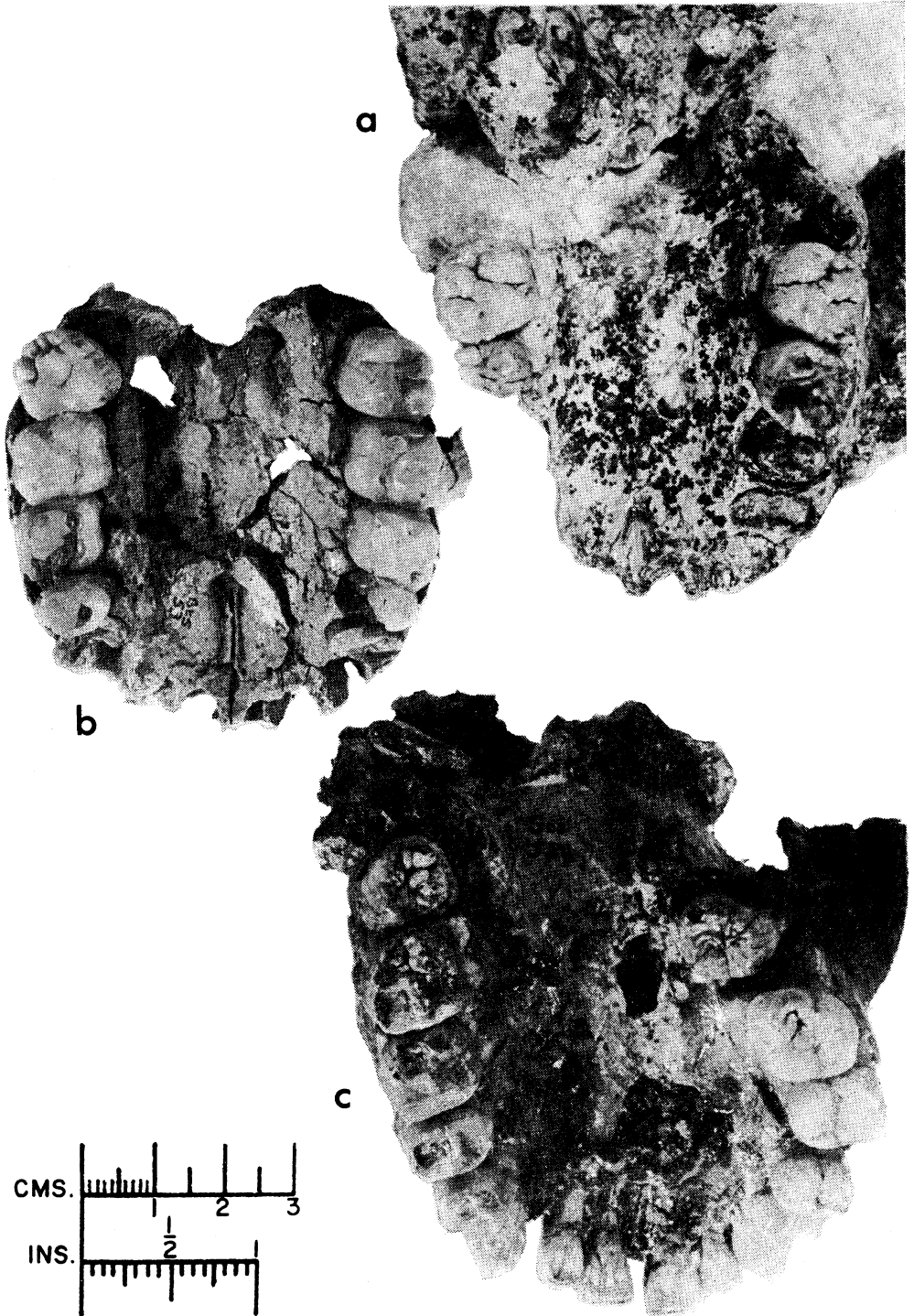


FIGURE 3. (a) SK 47, STS 53, and (c) STS 52A.

sents an interesting picture. The difference in incisive canal size is not useful because this information has not been presented for any robust australopithecine. I have observed both equal-sized and different-sized incisive canals (at the cranial aspect) in modern man and the African apes. The breadth of the incisive fossa is 2.3 mm in SK 80, measured from Figure 2 of Robinson's publication (1953b). Breadths for robust australopithecines range from 3.7 mm in SK 12 (Broom and Robinson 1952:Plate 1, Fig. 3) to 4.7 in Olduvai hominid 5, measured from the cast. In a very small sample of *Homo sapiens* ($n = 9$) the range is 2.2 mm to 4.6 mm. An even smaller gorilla sample ranges from 3.2 mm to 5.8 mm. Therefore, the range in the robust australopithecine sample including SK 80 is quite similar to the ranges in small samples of modern men and gorillas. The australopithecine size difference does not have obvious taxonomic or adaptive importance.

The remaining morphological features of the SK 80 palate present a curious assemblage, for they can be duplicated *item per item* on the palate of Olduvai hominid 5, a specimen that Robinson has clearly demonstrated belongs to the same taxon as the Swartkrans and Kromdraai material (1960, 1968). One need merely overturn the available cast to note the ridge from the incisive fossa to the I¹ alveolus, the concave surface between these ridges, and the depression of the palate midline just posterior to the incisive foramen. In addition, the range of variation described for robust australopithecines, including SK 80, has been illustrated for a South African sample of Blacks (De Villiers 1968:Figs. 44, 46, and 47).

The subnasal midline of SK 80 has a very slight median maxillary crest (Robinson 1953b:Fig. 3). This feature is quite variable in robust australopithecines: there is no apparent crest in SK 48, a slight crest in Olduvai hominid 5, and a more extensive one in SK 52. The median crest may be insignificant to absent in *Homo sapiens*, a condition termed "Cryptacanthic" by MacAlister (1898:230). Conversely, I have occasionally observed the crest in both chimpanzees and gorillas.

Gutgesell, quoting Robinson (1953b: 457), states that the anterior nasal spine "can be seen easily in side view." I have

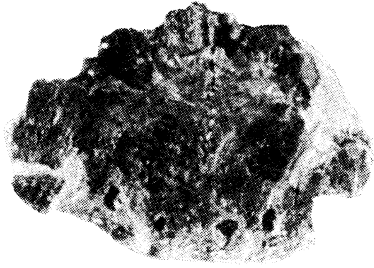


FIGURE 4. SK 80, top view (full size).

seen only one lateral view of SK 80, taken from the left by C. L. Brace. The left lateral second incisor can be seen clearly, and the socket for the left central incisor may be discerned, as well as the alveolar wall in the area of prosthion anterior to it. Thus, the view is either truly lateral or rotated slightly toward the left so more than the midline is visible. The anterior nasal spine is not visible in this view. Of course, one picture does not, in any sense, constitute an adequate demonstration. However, application of a straight-edge to Fig. 3 of Robinson's initial publication of SK 80 (1953b), a view of the fragment from above, suggests the same results. The anterior portion of the maxillary sinus is present. A straight line passing between the most anterior portions of the maxilla on either side of the fragment midline just touches the tip of the anterior nasal spine.

Visibility of the anterior nasal spine from the lateral view is a variable feature in some hominoid taxa. I have never observed it in gorillas. The chimpanzee described by Schultz (1958), with a projecting nasal spine, is clearly pathological. However, in a sample of twenty-three chimpanzees with anterior spines, I found two in which the anterior nasal spines, or tubercula nasale (Vogel 1963), were visible in the lateral view. Conversely, Jorgensen (1953:Plate 2) pictures an Eskimo cranium with the nasal margin invisible from the lateral view. Similar crania in which the midline of the nasal margin is not visible from the lateral view have been pictured by Larnach and Macintosh (1966: Plate 1) and others. The variation occurs with some regularity in *Homo sapiens*. Indeed, the very presence of an anterior nasal spine is subject to variation in hominoid taxa. About twenty-five percent of the chimpanzees and gorillas examined by

this author have no trace of it. The absence of the spine is one of the five variations common to *Homo sapiens* pictured by Martin and Saller (1957:Fig. 577). For instance, De Villiers reports complete absence of the anterior spine in twenty-nine percent of the South African Blacks studied (1968:286).

The lower margin of the pyriform aperture is clearly defined in SK 80, but not in the robust australopithecines. MacAlister (1898) terms these two types of margins "Oxycraspedote" and "Orygmocraspedote" respectively. They are both common variations in *Homo sapiens*. In a survey of North American aboriginal groups, Sullivan (1922:217) reports frequencies of the guttered form ranging from zero percent to nine percent, while the oxycraspedote margin ranges from six percent to sixty percent. This author has observed a nonguttered margin in about twenty percent of a large chimpanzee sample, although all of the observed gorillas have orygmocraspedote margins. As in so many other instances, it is reasonable to expect the robust australopithecines to include both conditions. Both are present in gracile specimens. STS 52 has a clear delineation at the margin, resembling the SK 80 condition (Tobias 1967a:114).

The relation of the nasal spine and the anterior insertion of the vomer distinguishes SK 80 from the robust australopithecines. However, I have identified both variations in chimpanzees, in gorillas, and in modern men from the Hamann-Todd collection. The line drawings presumably representing these variations (Robinson 1953b:Fig. 6, 1954:Fig. 2), although widely reproduced (see Figure 1 in Gutgesell's paper), do not accurately represent the distinctions that Robinson describes and pictures (1953b:457-461, Figs. 3, 4, and 5; 1954:183-186).

Robinson clearly describes both an anterior nasal spine and a corresponding posterior spine for SK 80 (1953b:457-458): the distance between these is one centimeter (1953b:Fig. 3). The anterior spine is a "slightly raised roughened region" (1953b:457). The posterior spine is halved (1953b:457-458). The anterior spine is equivalent to the tuberculum (or tubercula) nasale of anthropoids (Vogel 1963).

Robust australopithecines from Swartkrans, on the other hand, are reported with

only anterior nasal spines (1953b:459). As was the case with SK 80, many of these could as well be described as tuberculum (or tubercula) nasale. The question of whether or not a posterior spine exists in these specimens is meaningless because the vomer inserts directly against the back of the anterior spine, obliterating whatever lay behind it in the median plane (1953b:Fig. 5). Tobias clearly describes both an anterior and a posterior spine for Olduvai hominid 5 (1967a:112, Plate 18). The anterior vomer insertion is not mentioned in the text, nor is it apparent from the plates or the cast.

Anterior and posterior spines may merge to form a single eminence. I have observed both merged and separated spines in living man and the African apes.

There are only four different ways the vomer may insert: behind the posterior spine, contiguous with the posterior spine, between the posterior and anterior spines, or contiguous with the anterior spine or merged spines, as the case may be. As Duckworth noted (1895:337), the first two variations characterize most gorillas. This author has discovered these to be the most common conditions in both African apes, with the third and fourth variations present at low frequency. All variations but the first occur with some regularity in *Homo sapiens*. SK 80 illustrates the third variation, while the (other) robust australopithecines illustrate the fourth. Therefore, the variations present in the robust australopithecine sample including SK 80 regularly occur in gorillas, chimpanzees, and living men.

In considering those of Gutgesell's contrasts between SK 80 and the robust australopithecines that have been found to be valid, one is unavoidably left with the impression that these minute distinctions involve features that exhibit at least as much variation in almost every comparable hominoid taxon as they do in the robust australopithecines including SK 80. In both mandibles and maxillas, most of the suggested contrasts actually do not separate observed ranges of "Telanthropus" and robust australopithecines.

The Cranium. Howell (1969b) recently demonstrated that the maxilla SK 80 fits the remaining portion of the palate belonging to the associated frontofacial and occipital

fragments SK 846/847. These three pieces, then, make up one cranium SK 80/846/847, which he suggests is a "Telanthropus" (= *Homo erectus*) cranium. The frontofacial fragment is of considerable importance. The left portion of the face, nasals to zygomatic arch, extending slightly over the midline, is present save for the anterior portion of the maxilla (which is SK 80). With SK 52, it is one of the most undistorted faces from Swartkrans. It is significant that both Robinson and Tobias have independently and on numerous occasions identified both SK 846 and 847 as "Paranthropus." In fact, Robinson pictures a line drawing of the face, along with the face of SK 52, to illustrate the zygomatic process contour variation of "Paranthropus" at Swartkrans (1967:89:Fig. 5B). With so much of the cranium present, I do not believe that both Robinson and Tobias—the two workers having the greatest amount of firsthand experience with the australopithecine specimens—could independently and consistently have confused a *Homo erectus* cranium (the taxon into which Robinson now puts "Telanthropus") with a robust australopithecine cranium. If these two workers, with their experience and expertise, are both capable of such a misidentification, it could only show how very similar the crania of robust australopithecines and *Homo erectus* are.

The important point is that whether Howell (1969b) is correct in calling SK 80/846/847 "Telanthropus" (= *Homo erectus*), or Robinson and Tobias are correct in calling SK 846/847 "Paranthropus," or even whether Robinson and Tobias now decide to call SK 80/846/847 *Homo erectus*, the fundamental and detailed similarities of robust australopithecines and *Homo erectus* have been irrevocably demonstrated because of an accident of nature, separating a maxillary fragment anterior to M² from the remaining cranium.

Awareness of this close relationship illuminates one's understanding of why a number of specimens such as Olduvai hominid 16, the "Meganthropus" mandibles, and the "Telanthropus" specimens themselves are consistently identified by some experienced workers as robust australopithecines and by others as *Homo erectus*.

Robinson (1960:457) identifies SK

846/847 as a "mature adult *Paranthropus*," and uses it in a discussion indicating that Olduvai hominid 5 falls within the "Paranthropus" range of variation in lacking a buttress at the anterior root of the zygomatic arch. One knows that he has reconstructed the full face, identifying the midline, because he published the proportional width of the inner orbital area to that between the external orbital angles—that is, the ratio of the posterior innerorbital breadth (*la-la*), Martin number 49, to the bijugal diameter (*ju-ju*), Martin number 45(1)—as 26.2 (1960:456). With the ratio for SK 48, 25.3, he argued that the Olduvai hominid 5 value, 26.6, is almost identical to the "Paranthropus" ratios.

Tobias (1967a) utilizes SK 846/847 extensively in his monograph comparing Olduvai hominid 5 with "Paranthropus." The occipital region is identified as a "Paranthropus" specimen that, along with SK 47, has an occipitomastoid crest similar to Olduvai hominid 5: the main component of the crest is temporal and the occipital contribution less than that of *Homo erectus* (1967a:29). A sigmoid groove is identified on one of the fragments (1967a:66). In discussing the masseteric impressions on the zygomatic arch, SK 846/847 is used, along with SK 52, to illustrate the *maximum* extent of masseter attachment at Swartkrans. Of these two crania, "the masseter is confined to the zygomatic bone" of SK 52, but in SK 846/847 "it encroaches for as much as 8.5 mm on the maxilla" (1967a:120). In both SK 46 and SK 48, the impressions are less. The only robust australopithecine with a more rugged and extensive impression than SK 846/847 is the Olduvai specimen in which the impression goes as much as 17.7 mm on to the maxilla (1967a:119). In a discussion of pneumatization, SK 846/847 is again identified as a "Paranthropus" skull from Swartkrans" (1967a:126). A bone canal, similar to that of the Olduvai specimen, for conveying the infraorbital nerve and associated vessels through the expanded superior compartment of the maxillary sinus is identified in both specimens.

The features described for SK 846/847 that are distinct from the condition in *Homo erectus* are the form of the occipitomastoid crest and the extent of the masseteric impression on the zygomatic arch. In the latter characteristic, an obvious part of the masti-

catory complex, the cranium is robust for a robust australopithecine!

The final characteristic Tobias describes for SK 846/847 is the supraorbital torus (1967a:104–105). Tobias shows that while vertical torus thickness at the highest point of the orbit overlaps between robust australopithecines and *Homo erectus*, the overlap is in the upper part of the australopithecine range. Three of the five robust australopithecine specimens, including SK 846/847, have torus thicknesses far below the *Homo erectus* range, indeed, less than half the average thickness of this taxon (see Table 4). Eight *Homo erectus* specimens average 16.4 mm and range from 12.5 mm to 25.0 mm.

In sum, the published descriptions of this specimen all indicate that it is a robust australopithecine. The three features described for it that *could* distinguish robust australopithecines from *Homo erectus*, so distinguish this cranium. A rather robust masticatory complex is indicated while at the same time the supraorbital torus is far more gracile than in any *Homo erectus* specimen. It is also more gracile than Olduvai hominid 16, with a torus thickness this author measured between 10 mm and 11 mm from the published scaled photograph (L. S. B. Leakey 1966:Fig. 6).

C. L. Brace has kindly allowed me to utilize several pictures and measurements of the original specimen. It was possible to identify the midline of the face Robinson utilized in his ratios (1960:456). With both the lachrymal and the jugal points visible on the *norma frontalis* photograph, one needed to know only the distance perpendicular to the sagittal plane between these points in order to find the midline indicated by the ratio, with simple algebra. With the midline so identified, it became possible to take other breadth measurements from the photograph. Measurements for some of the australopithecines and a few *Homo erectus* specimens are given in Table 4.

While the face is clearly robust, its dimensions are small. The perpendicular height was taken from the center of the orbits' upper border to the alveolar margin. This distance measures 78 mm. Values for other australopithecines are in Table 4. All other robust specimens are larger; 90 mm was measured for the Broken Hill cranium. The

alveolar height (33 mm) is relatively and absolutely great. The average for ten robust australopithecine specimens is 34 mm (29 mm–43 mm), but only four have greater heights. The average for seven gracile australopithecines is 28 mm (21 mm–33.5 mm). The height is greater in only one of these. The two *Homo erectus* specimens in which this distance can be measured ("Pithecanthropus" 4 and Peking facial fragment OI) have heights of 31.5 mm and 23 mm. I initially suggested "reduction of facial size" (1968:485) as an early trend in hominid evolution. At the time, it hardly seemed necessary to point out that *relative* facial size was meant, although Gutgesell's subsequent interpretation of the suggestion demonstrates otherwise. She concludes: "On the basis of his reasoning, Rhodesian man would be considered a more primitive australopithecine than *Paranthropus*." In a much larger cranium, the alveolar height may approach, or slightly exceed, some australopithecine values. In the Rhodesian cranium, the superior facial breadth is fifty-six percent greater, the perpendicular facial height is fifteen percent greater, and the alveolar height is eight percent greater than these values in SK 80/846/847. Nonetheless, to avoid future confusion, I clearly should have suggested that alveolar height is reduced relative to the facial and cranial size in Middle and Upper Pleistocene hominids. Then, even megafaced specimens such as the Broken Hill cranium can be used as an example of such reduction when compared with SK 80/846/847.

An inordinately large percentage of the facial height is taken up by the very robust zygomatic bone of SK 80/846/847. When expressed as a ratio to the orbitoalveolar height (distance of the alveolar margin below the lowest point on the orbit, Martin 48(3)), the relative projective height of the zygomatic bone (distance of the *zm-zm* line below the lowest point on the orbit, Martin (48(3a))) is 60 in this specimen. The only robust australopithecine approaching this is the Olduvai specimen, with a ratio of 62. Other australopithecines, robust and gracile, are far less. In the Broken Hill crania, this ratio is 47. Although the ratio cannot be calculated for the *Homo erectus* zygomatic bones, three fragments from Peking and one from Java ("Pithecanthropus" 6), the avail-

able dimensions of all these zygomatic bones are less than those of SK 80/846/847, while every indication is that the orbitoalveolar heights would (if measurable) be greater.

The perpendicular division of the face above and below the Frankfort Horizontal (FH) is within the robust australopithecine range, with the relative portion above FH in the upper part of the range. The ratio of orbit height to perpendicular facial height is 40 in this specimen.

The orbits are small, following from the small face. Both height (31 mm) and breadth (35 mm) fall at the bottom of the robust australopithecine range. Average height ($n = 5$) and breadth ($n = 7$) for robust australopithecines is 38 mm and 33 mm. For gracile specimens these averages are 32 ($n = 5$) and 31 mm ($n = 5$), while for *Homo erectus* they are 47 mm ($n = 4$) and 39 mm ($n = 3$). Thus, orbit size is further from *Homo erectus* than from either of the australopithecines. The orbital index, 89, is at the maximum end of the robust australopithecine range.

The nasal bones follow the pattern of all australopithecines, except Olduvai hominid 5, being narrower on the superior margin (4 mm), and broader on the inferior margin (12 mm). The superior margin is very narrow for a robust specimen; four other specimens range between 9 mm and 12.7 mm. On the other hand, the inferior margin is almost exactly the same as in SK 48 (11 mm). The superior nasal bone margin is well known for *Homo erectus*: five specimens range from 16 mm to 18 mm. Tobias calculates the *B/L* index of nasal bones (superior breadth and lateral length), illustrating that the breadth of all australopithecine nasal bones is small relative to length when compared to *Homo erectus*. The single *Homo erectus* value for this ratio is 70 (Peking skull 10). Table 4 gives the australopithecine ratios—all small. SK 80/846/847 has a ratio of 23.

In absolute dimensions, the facial breadths are small. Comparison with the robust australopithecines varies from as close as the inner biorbital breadth (*fmo-fmo*) to as far as the biangular breadth, measured at the lower angles of the anterior zygomatic arch root (Martin 46a). Both of these measurements are below the observed *Homo erectus*

ranges: inner biorbital breadth ranges 90 mm–143 mm ($n = 6$), biangular breadth ranges 68 mm–88 mm ($n = 3$). Indeed, all of the facial breadths measured for SK 80/846/847 are below the observed *Homo erectus* ranges.

The breadth measurements can be expressed relative to perpendicular facial height (middle superior orbit rim to alveolar margin). When this is done, a definite pattern of breadth variation emerges. The relative breadths of SK 80/846/847 are *above* the range of the other robust australopithecines superior to the bijugal breadth, within this range for the bijugal breadth, and *below* this range inferior to the bijugal breadth. The relative facial breadths decrease inferiorly when compared to the four other robust specimens allowing calculation of the appropriate ratios (SK 46, SK 48, SK 52, Olduvai hominid 5). It is possible that this indicates the midline used in the facial reconstruction should be rotated slightly counterclockwise. No comparisons with *Homo erectus* are possible. The ratios for the upper portion of the face are higher than in the three gracile specimens allowing comparisons (STS 5, 17, and 71). In the lower portion, STS 5 and 71 are somewhat broader, while STS 17 is somewhat narrower. The Broken Hill specimen is relatively and absolutely broader in all cases.

In the lateral view, the nasal bones are visible. This is not true in any other robust australopithecine. Following the line of the nasals, the face appears to be quite prognathic. This can also be seen from the maxilla SK 80, in which the midline of the lower face forms an angle of 30° with the occlusal plane. Table 4 gives angles for other australopithecines. While these angles are approximate, SK 80/846/847 *could* be as prognathic as STS 5, just as SK 52 is as prognathic as STS 52, and so on.

One can compare this specimen to individual robust australopithecines. In proportional heights it is most like Olduvai hominid 5. In breadths taken relative to other breadths, the specimen is most like SK 46. In breadths taken relative to height (excepting the biangular breadth), the specimen is most like SK 48 and SK 52. Finally, in general appearance from all views, it is most like SK 52. The australopithecine specimen most closely matching its absolute dimensions is MLD 6.

TABLE 4. COMPARISON OF SK 80/846/847 WITH SOME LOWER AND MIDDLE PLEISTOCENE HOMINIDS*

	SK 80/846/847	SK 12	SK 46	SK 48	SK 7.4	SK 7.8	SK 12.4	TM 1517	OH 5	MLD 6	TM 1511	STS 5	STS 17	STS 17	STS 17	STS 17	STS 52	STS 71	Chad 9	OH 9	Lan-tian	Peking 12
Supraorbital torus midpoint thickness	7.8				7.4	7.8	12.4		13.7		9.6									25		15.1
Perpendicular facial height (superior mid orbit-alveolar margin)	78		90	88	89	89			106	74	80	79						85				
Ratio: projective zygomatic bone height, orbitoalveolar height	60		48	48	54	50			62		38	48	36	37	31							
Ratio: orbit height, perpendicular facial height	40		36	37	42				32	44	38	39			35							
Orbit breadth	35		38	38					40		32	34			33	46				45	57	38
Orbit height	31		33	32	38				33	32	30	31			30	35				35	41	40
Ratio (H/B)	89		84	84					83		88				91	76				76	72	105
Superior nasal bone breadth	4	9	9	9					12.7	5.5	2		9							17		17.5
Inferior nasal bone breadth	12		11	11					6.7	11	17											
Ratio: nasal bone superior breadth, lateral length	23		30	30					41	29	10											
Breadths																						
Anterior innerorbital	16		24	24					23	15	20	16			15	19				27	25	32
Outer biorbital	96		102	111	108	104			116		110	98	70		85	116				134	151	119
Inner biorbital	86		88	94	90	84			100		85	82	63		78	102				116	143	106
Bijugal	96		97	119	124	118			123		115	108	92		98	117						
Midfacial	80	113	97	95	94	106			122		106	90	77	88	100	93						
Biangular (anterior zygomatic arch roots)	53	73	72	77	76	69			74	52	70	67	54	68	72	56						88
Angle between lower face and occlusal plane	30°	60°	55°	65°	45°				70°		40°	30°	30°	45°	50°							

* Measurements in mm.

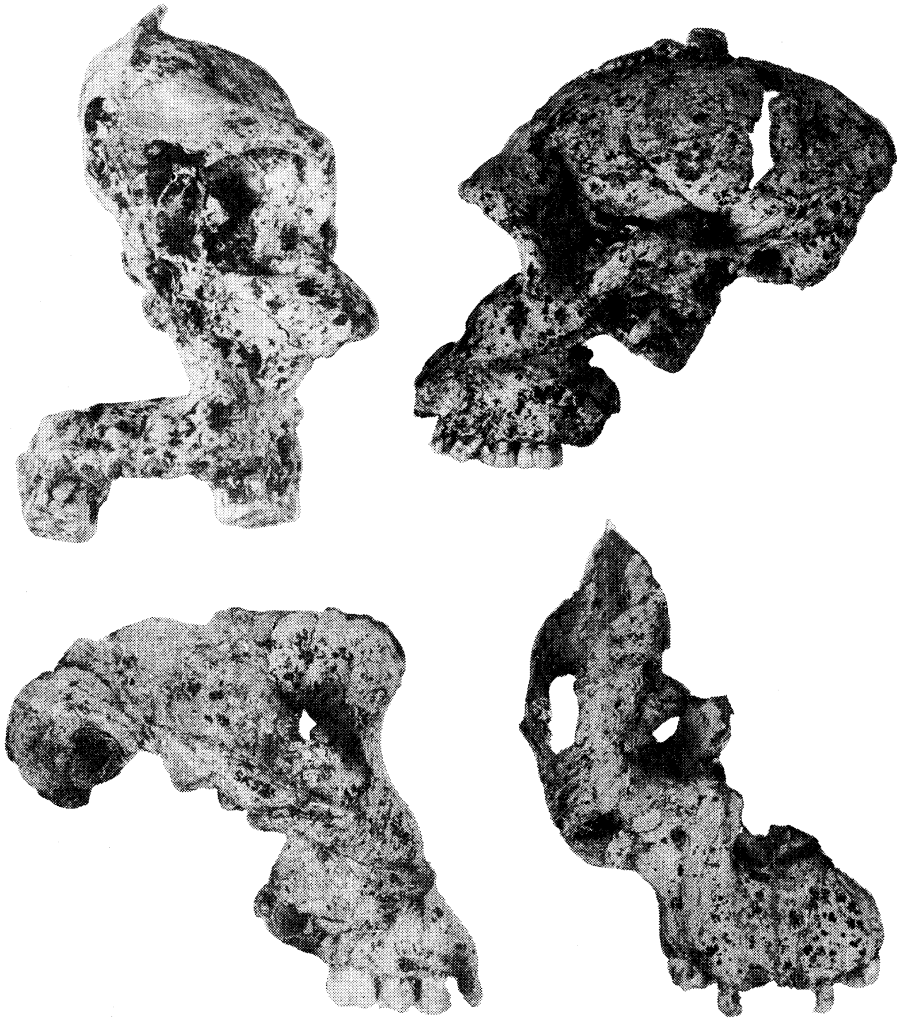


FIGURE 5. Front and side views of SK 46 (top) and SK 52 (bottom). Shown one-half life size, except the side view of SK 46, which is somewhat smaller.

One must bear in mind that everything discussed here, with the exception of those few comparisons that utilized the front end of the maxilla, were visible to both Robinson and Tobias when they identified the specimen as a "Paranthropus." Many of the features in *normal frontalis* are apparent in Robinson's line drawing (1967:Fig. 5B). The general impression of the cranium is one of a small, prognathic robust australopithecine relatively broad in the upper portion of the face and narrow in the lower por-

tion, showing an extensive area for masseter attachment and a concomitantly large zygomatic process, nasal bones of australopithecine proportions, and a light supraorbital torus when compared with all *Homo erectus* specimens. Although not enough of the frontal is present to be certain, there was probably a sagittal crest. At the midpoint of the orbit, the temporal line is only 13.3 mm behind the orbit (Tobias 1967a:104). This distance is greater in the other robust australopithecine crania, although the difference

may be due to size variation. In *all Homo erectus* crania, a measurement from the midpoint of the orbit posterior to the temporal line is impossible. The line becomes anterior-posterior without reaching sufficiently toward the midline to allow the measurement. In sum, the australopithecine reliance on masticatory function is evinced by the morphology of SK 80/846/847.

Dental Morphology

Gutgesell's comparison of dental morphology leaves little necessity for discussion. Most of the features she associates with "Telanthropus" are, by her own admission, also present in the "Paranthropus" sample utilized. Features that presumably distinguish the latter sample are described as "common," or having a "tendency," or "present in all but one" or "almost invariably." The other variants, however, are the same as those found in "Telanthropus." Surely, sharing features present in the minority of a sample is not grounds for exclusion from the sample.

The SK 80 canine root has already been discussed, and her contentions shown incorrect. With respect to the P³ root, in both teeth "no completely intact roots of P³ are present" (Robinson 1953b:484). The socket measurements for the left socket are about 6 mm by 10 mm. I can find no published literature concerned with the P³ root of any robust australopithecine. The only cast available in my laboratory with a visible P³ socket, allowing comparison of socket measurements with SK 80, is SK 47. In SK 47 the right P³ socket is present, measuring 5 mm by 10.5 mm. At least in the length and breadth measurements, it appears that there is no size difference. No root length information is available. Given Robinson's description of how much P³ remains (i.e., root fragments), how would one know whether the crown "is narrower at the cervical line than at the occlusal surface"? In any event, it is easy to find robust australopithecines in which the P³ crown is not narrower at the occlusal surface than at the cervical line. In SK 74a, one of the four P³ roots pictured by Robinson (1956:Fig. 15g), the diameters at the occlusal surface and cervical line are the same. When the occlusal surface diameter exceeds that at the cervical line in the P³ of

Homo sapiens, the diameter is always buccal-lingual (Kraus, Jordan, and Abrams 1969:48-61). It is therefore significant that the view of SK 74a is buccal. Robinson also illustrates a "Paranthropus" P³ (SK 24) in which the root system tapers downwards (1956:Fig. 15h), contradicting Gutgesell's claim: "in *Paranthropus* the root is wider at the apex."

Gutgesell states: "The buccal faces of the molar crowns differ in the two forms with regard to grooves, pits, and tubercles." She is quoting Robinson (1953b:475-476). Robinson is only describing the situation for SK 15 in this section. In SK 15 the mesio-buccal groove continues to the cervical line in all three molars. There is a small pit associated with this groove in the first two, but not the third. A tubercle is never associated with this pit. He contrasts the situation in "Paranthropus," stating that the mesio-buccal groove instead *terminates* in a pit in the middle of the buccal face. A tubercle often forms the outer surface of the pit. Actually, these features show considerable, but equivalent, variation among the "Telanthropus" specimens as well as among the robust australopithecines and in modern man. The excellent published external picture of SK 45 (Broom and Robinson 1950a:Fig. 4) shows no indication of a groove near the cervical border in M₂ (the "Paranthropus" condition). The buccal face of M₁ is completely lost. Concomitantly, both SK 34 (Broom and Robinson 1952:Plate 1, Fig. 4) and Omo mandible L7-125 (Howell 1969a:Figs. 8 and 9) have mesio-buccal molar grooves that extend all the way to the cervical border (the "Telanthropus" condition). Robinson admits of considerable variation in modern man, stating: "Occasionally teeth with buccal faces almost identical with those of australopithecines are to be found" (1953b:476). The frequency of such specimens must be greater than initially thought; two recent atlases of dental anatomy illustrate the "Paranthropus" condition in the buccal faces of all three molars (Schroeter 1966:Plates 11-16; Kraus, Jordan, and Abrams 1969:Figs. I-161, I-162, and I-163). In both volumes, the tubercle on M₁ terminating the mesio-buccal groove is particularly well defined.

The unnamed differences in cusp wear pat-

tern supposedly refer to the fact that on M_1 of both SK 15 and SK 45, the greatest wear is buccal (Broom and Robinson 1952: Plate 8, Figs. 27 and 30), whereas heavier lingual wear is presumably characteristic of "Paranthropus" (Robinson 1956: Fig. 4). However, heavier buccal wear is characteristic of numerous robust australopithecines, including TM 1517, the Natron mandible, SK 74a, and SK 6. The last mandible is the type specimen from Swartkrans!

Finally, there is the "considerably reduced size" of M_3 in SK 45, and its small backwards projecting root. The comparative sample for roots among the robust australopithecines is two (Robinson 1956:113), hardly a sufficient number to indicate the range of this highly variable feature. With respect to crown size, Robinson *estimates* that M_3 was both shorter and narrower than M_2 on the basis of the socket size. Out of eighteen M_2/M_3 comparisons that could be made for robust australopithecines, one M_3 was smaller in both length and breadth, fourteen were smaller in breadth only, and three were larger in both dimensions. This range, computed without the "Telanthropus" specimens, indicates that the "Telanthropus" condition falls within the observed robust australopithecine range.

Many years ago Le Gros Clark noted that the molar cusp pattern of "Telanthropus" demonstrates "clearly enough its australopithecine affinities" (1949:257). Eighteen years has not changed his mind (1967:41-42). There is nothing in Gutgesell's discussion even to suggest his conclusion should be questioned.

Tooth Size Variation

Meaning. M_1 size was initially suggested as a sorting criterion to distinguish "eu hominids" from "Paranthropus" (Broom and Robinson 1952; Robinson 1953b). Robinson has clearly delineated his use of this concept, describing sorting criteria as "a set of absolute criteria that will allow one to distinguish without fail every single individual of one sort from every single one of another if the groups they represent are to be regarded as good species" (1967:74). Following Le Gros Clark (1949:39), I (1968:487) questioned the use of M_1 size as a sorting criterion for hominid taxa. The great overlap between ranges of M_1 size variation for robust

australopithecines, *Homo erectus*, and *Homo sapiens* was demonstrated 1968:488-490, with some individuals of both the second and third species closely approaching the mean for the first. Yet in considering this, Gutgesell concludes:

Had Wolpoff arbitrarily chosen "Sinanthropus" 38 for comparison instead, he would have found differences of 2.71 and 2.31 sd. . . . Consequently he would have concluded that M_1 is an excellent criterion for distinguishing hominids.

This paragraph concerned with *Homo erectus* and the following one in which she says essentially the same thing regarding extant populations come to the crux of Gutgesell's persistent confusion of individuals, populations, and taxa. I did *not* "arbitrarily" choose the "Pithecanthropus B" or the Australian Aborigine maximum first molars, but rather did so quite purposefully, in order to demonstrate that M_1 size is not a sorting criterion for *individual* specimens, and therefore is not of taxonomic relevance for distinguishing hominid *taxa*. This is very different from claiming that hominid species, or for that matter populations within a species, may not have very different *average* M_1 dimensions. Indeed, I have recently shown that the maximum M_1 length and breadth differences among extant population averages, 1.73 mm and 1.79 mm (Wolpoff 1970: Table 51), far exceed the respective differences between robust and gracile australopithecines, 0.7 mm and 1.0 mm shown in Table 5.

One must remain aware of this confusion. It exists throughout the section and underlies many of the comments made therein. Curiously, although she finally concludes that M_1 size does *not* distinguish hominid taxa, she derives *support* for the generic separation of the "Telanthropus" specimens from this conclusion.

Statistical Tests: Procedures and Assumptions. In the original paper, I state: "Even if M_1 size had taxonomic value, it does not distinguish 'Telanthropus' (1968:487)." With the increased data now available, more than doubling the available size, this statement remains true.

For their initial statistical tests, Broom and Robinson (1952:117) began by assuming "that *Telanthropus* is a member of the

P. crassidens population." The two mandibles were obviously closely related to the other hominids at Swartkrans. By approaching their taxonomy with this assumption, the authors were following the most common, and probably the most useful, taxonomic procedure (Simpson 1961; Mayr 1969). After convincing themselves that the "Telanthropus" M_1 size could not arise in the "Paranthropus" population at Swartkrans, they then calculated the sample parameters without the "Telanthropus" specimens. My subsequent discussion did not, as Gutgesell repeatedly claims, ignore the second set of calculations. With the demonstration that molars of the "Telanthropus" size could be expected to arise in a robust australopithecine sample (Wolpoff 1968:488-490), there was no reason to calculate the sample parameters without them. As was initially stated, I "followed the exact procedure of Broom and Robinson" (1968:489).

Following these accepted procedures in relating new specimens to known taxa that are clearly closely related does not, as Gutgesell suggests, render the comparison biologically meaningless. Rather, it has always been the opposite procedure that leads to evolutionarily abhorrent conclusions. For example, a recent revision has reduced twenty-seven genera and fifty-two species of dryopithecines thus established to three genera and seven species (Simons and Pilbeam 1965). When initial sample sizes are relatively small, new specimens can be expected to lie at the extremes of the observed variation. When one begins with the assumption that new, and subsequently different, specimens obviously closely related to the sample should be initially considered separate taxa and, as it were, lays the burden of proof on demonstrating the initial assumption false, the multiplication of taxonomic categories inevitably results. Tobias (1969:27) recently adopted this procedure, suggesting that the small middle breccia teeth at Sterkfontein, the robust remains at Makapansgat, and even one of the two "Telanthropus" mandibles (SK 45), represent new taxa not previously identified at the respective sites. The approach is bound to be successful; all ranges of variation have both large and small ends. I choose to follow the recommendations of Mayr (1969), Simpson (1961), Simons (1967), McAlester (1962),

TABLE 5. COMPARATIVE PARAMETERS OF M_1 DIMENSIONS

	Length (mm)				Breadth (mm)				Area (mm ²)				
	\bar{X}	Range	N	CV	\bar{X}	Range	N	CV	\bar{X}	Range	N	CV	
Australopithecines													
<i>gracile</i>	13.6	11.3-16.5	25	8.9	13.2	11.5-15.0	25	7.2	180	155-248	24	13.4	
<i>robust</i>	14.3	11.3-16.8	43	8.7	14.2	11.0-18.7	40	9.5	204	124-314	40	15.8	
<i>H. erectus</i>	12.7	9.9-14.7	30	7.7	12.0	10.1-13.7	29	7.2	154	100-182	29	13.1	
<i>H. sapiens</i>	11.6	9.0-14.1	558	7.5	11.0	8.3-13.0	558	7.2	127	84-179	558	12.6	
Australian													
Aborigine	12.3	11.0-14.0	189	8.6	11.9	10.0-13.5	186	6.3	146	112-175	181	12.8	
New Britain	11.8	10.0-13.6	77	6.0	11.4	10.1-12.6	76	5.4	134	103-170	76	10.1	
Caucasoid	11.2	9.8-13.0	115	7.4	10.7	9.2-12.7	115	6.1	121	90-159	115	12.0	
Harappa (India)	10.6	9.0-12.5	49	5.7	10.3	8.5-12.0	48	7.5	109	90-144	48	9.5	

and others in following the procedure initially utilized by Broom and Robinson.

Gutgesell does not have a correct understanding of the Chauvenet rejection criterion. This criterion, suggested by Parratt (1961:176-178), is not a way of dealing with "bad" measurements, just as it is not a way of placing specimens in taxa. In comparing a single specimen, or a few specimens, to a sample, the only thing a statistical test can determine is whether or not one can reasonably expect the specimen to occur within the sample on the basis of the distributional properties of the sample. If the test shows that one *cannot* reasonably expect the specimen to so occur, there is no *necessary* biological implication; tests often show specimens at the extreme ends of the variation in known taxa to be "significantly different" from the mean. On the other hand, if the test shows that one *can* reasonably expect the specimen to so occur, taxonomic distinction is *unjustified*, although it may in reality exist. In other words, these tests have only one legitimate use. If their results indicate that the sample distribution reasonably includes the specimen, biological separation is not justified on that basis.

The choice of which test is appropriate depends on the distribution properties of the sample: the sample size, deviations from normality, and so on. The problem of what constitutes a "reasonable expectation" is another matter. The significance level of deviation from the mean is determined by the test. At what level of significance should one reject the hypothesis that the specimen may be expected to occur in the sample? five percent? one percent? Authors usually choose, quite arbitrarily, one of these. In using 2.5 standard deviations from the mean, Broom and Robinson were suggesting rejection with a probability of error of 1.24 percent or less.

The Chauvenet criterion simply suggests a less arbitrary way of deciding the appropriate significance level for rejection by relating it to the sample size. Rejection is justified when the probability of occurrence is less than $1/(2n)$. When samples are small, and their parameters subsequently less certain, smaller deviations are rejected. As samples increase larger deviations become acceptable. However, as the sample size becomes very large, the size of acceptable deviations does not proportionally increase, as Gutgesell suggests. A sample size of fifty allows

rejection at greater than 2.58 standard deviations from the mean, while even a sample size approaching infinity does *not* justify rejection at four standard deviations from the mean.

One final point: The Chauvenet criterion is conservative in that it rejects *too much* when the samples are relatively small. Even so, Parratt clearly states that the parameters of the sample are calculated "before the measurement in question is rejected." In a discussion of distribution properties commonly utilized in the physical sciences, Margenau and Murphy (1956:516) also calculate distribution parameters *before* a point possibly not predicted by the distribution is rejected. If this procedure rejects too much, how much *more* would be rejected if the sample parameters were calculated without the questionable specimen? It seems that both *biologically* and *statistically*, Gutgesell is incorrect in suggesting calculation of the sample parameters excluding a closely related but questionable specimen, when the status of the specimen is tested.

Statistical Tests: Results. In the initial tests, this author utilized the difference between the SK 15 value and the robust australopithecine mean in standard deviations as a test statistic. The robust australopithecine sample consisted of fourteen teeth from Swartkrans (not eighteen), three from Kromdraai, two from Java (not one), and one from Natron (not two). When two teeth from a single specimen were available, one was chosen at random so that these specimens would receive equal weight with those represented by only one tooth in this small sample. Thus five teeth, although no individuals, were removed from the Swartkrans sample and one tooth from the Natron sample. SK 15 was included in the Swartkrans sample. SK 45 was not, although it could have been and Gutgesell assumes that it was. Parratt (1961:177) states that when there are two questioned measurements, they *both* be included when testing for the rejection of one. Had both been included, the standard deviation would have been greater and the sample mean smaller, so that the test statistic would have put SK 15 even closer to the mean. Finally, when all available teeth are used, including SK 15 and SK 45, the test statistic places *both* "Telanthropus" specimens within the bounds suggested by both

Broom and Robinson and by the Chauvenet criterion.

Gutgesell tests the average values for SK 15 and SK 45 against the robust australopithecine mean and although the population from which the parameters were calculated did *not* include SK 45, the test statistic indicated that rejection was not justified. Only when all of the *teeth* (as opposed to specimens) are included in the sample (still without SK 45) can Gutgesell show that the test statistic for SK 15 mean length, although not breadth, lies slightly outside the indicated Chauvenet range. The different results stem from the fact that four of the six specimens represented by two teeth have above average lengths. Two of these (SK 6 and Natron) make up the maximum of this range.

This procedure is apparently acceptable to Gutgesell. Therefore, the entire test has been reworked with the much larger sample size now available to me, utilizing every tooth in the sample. (The expanded sample includes all material available to Brace in 1968.) There are thirty-five teeth from Swartkrans, three from Kromdraai, two from Java, two from Natron, and one from the megadont Omo mandible L7-125. Data for the Omo mandible were published by Howell (1969a:1238), and the two Java "Meganthropus" mandibles by Tobias and von Koenigswald (1964:Table 2) and Marks (1953:31). All of the remaining measurements were taken on the original specimens by C. L. Brace and are utilized here with his kind permission.

In Table 5, the relevant parameters (average, range, sample size, and coefficient of variation) are calculated for robust and gracile australopithecines, *Homo erectus*, *Homo sapiens*, and four extant populations covering the modern size range. The gracile australopithecine data were measured by Brace. I have already published the sources of the remaining data (1970), much of which I measured. Length, breadth, and area (length times breadth) are considered.

The Chauvenet principle suggests that deviations in excess of 2.5 standard deviations from the mean are necessary for valid rejection from the robust australopithecines. In this case, the criterion is the same as that utilized by Broom and Robinson. Using measurements taken on the original specimens by Brace, the test statistics calculated for the length, breadth, and area of SK 15

are 2.4, 1.7, and 2.2 standard deviations. For SK 45 they are 2.4, 2.4, and 2.4 standard deviations. Therefore, rejection is not justified for any of the size measurements of either M_1 .

As Gutgesell realizes, both "Telanthropus" lower first molars are highly worn. Most of the data in the original tests were taken from Robinson's publication and thus represent only those teeth not heavily worn; for M_1 , only eighteen of the twenty-nine available teeth at Swartkrans were used (1956:101). In comparing this selected sample to the two heavily worn "Telanthropus" teeth, it is little wonder that size differences, particularly in length, were overemphasized. Nonetheless, both the original comparison and the comparison discussed here with double the sampling size and a more representative sample indicate that rejection on the basis of M_1 length, breadth, and area is unjustified for both mandibles.

Robinson attempted to compensate for the extreme wear on M_1 , suggesting that the original dimensions for SK 15 approached 11.9 mm by 11.9 mm, and for SK 45, 11.8 mm by 11.5 mm (1953b:472, 479). The test statistic was calculated using these, rather than the uncorrected values. The length, breadth, and area values are 1.9, 1.7, and 1.9 standard deviations for SK 15 and 2.0, 2.0, and 2.1 standard deviations for SK 45.

The same procedure was attempted for the single M^3 found in the cranial-facial fragments (SK 846/847) now associated with SK 80. The relevant parameters are given in Table 6. The dimensions of this tooth are 11.5 mm by 15.5 mm. It is the shortest, although not the narrowest, tooth in the robust australopithecine sample. The Chauvenet criterion suggests that 2.4 standard deviations must be exceeded for valid rejection from this sample. The test statistics calculated for the length, breadth, and area of this tooth are 2.4, 1.2, and 2.0 standard deviations. Again, no valid rejection is indicated.

If one follows the procedure I suggested, and utilized in 1968, representing each *individual* only once, the following results: sample sizes are smaller, sample variability is increased (the dependent measurements have been removed), sample averages are decreased, the amount of variation suggested by the Chauvenet criterion is reduced. The

TABLE 6. COMPARATIVE PARAMETERS OF M³ DIMENSIONS

	Length (mm)			Breadth (mm)			Area (mm ²)					
	\bar{X}	Range	N	CV	\bar{X}	Range	N	CV	\bar{X}	Range	N	CV
Australopithecines												
gracile	13.6	11.3-17.1	22	11.1	15.8	14.1-18.9	20	8.5	218	177-323	19	19.8
robust	14.6	11.5-18.3	32	8.7	17.0	14.7-21.4	33	7.7	250	178-345	31	14.4
<i>H. erectus</i>	10.2	8.7-13.8	21	9.1	13.0	10.4-16.9	31	15.5	144	91-227	21	29.2
<i>H. sapiens</i>	9.5	7.0-15.0	331	13.5	10.8	5.0-14.4	336	14.1	102	46-173	330	20.1
Australian												
Aborigine	10.0	8.0-13.0	142	11.0	12.3	9.4-15.0	193	11.2	124	88-164	139	19.4
New Britain	9.4	7.8-12.0	52	8.3	11.7	10.0-13.6	55	7.5	110	87-150	52	13.2
Caucasoid	8.9	7.3-11.5	38	12.1	11.1	9.0-14.0	38	10.8	100	68-134	38	19.7
Lapps	8.0	5.0-10.4	366	9.7	9.7	5.3-11.9	355	9.9	78			

net effect is that for all three specimens the distance from the mean in standard deviations is less and, although the Chauvenet criterion is lower, rejection is not justified in a single case.

The same tests were attempted using SK 15 alone and SK 45 alone, necessitating the recalculation of all parameters and statistics. The results were quite simple; the test statistic, recorded here to two digits, was not changed in any of the six possible instances.

Finally, we can approach the entire problem in the manner first suggested by Gutgesell, although I do not support the approach. We may begin by assuming that there are two distinct samples to be found among the robust australopithecines: (1) SK 15, SK 45, and SK 80/846/847, and (2) all other specimens. She suggests both the *t* test and the less powerful but less assuming Mann-Whitney *U* test as ways of comparing the samples. The *t* test assumes both normal distributions and equal variances in the samples. Because obviously neither condition is met, she makes an excellent case for using the Mann-Whitney *U* test, "the most useful nonparametric alternative." One wonders why she did not follow through the suggestion and use the nonparametric test.

I applied the Mann-Whitney *U* test to both M₁ and M³ samples. This test gives the probabilities that the samples are the same. As to what probability should not be exceeded to justify separation, we may again use the Chauvenet criterion, insisting that the calculated probability must not exceed 1/2*n*. For all three dimensions in both cases (M₁ and M³), the test gives probabilities well in excess of 1/2*n*. The measurements used were taken on the original teeth. The corrected measurements would give yet higher probabilities. Therefore, even following a procedure that begins with the *assumption* of two samples, the samples cannot be validly distinguished in both mandibular and maxillary cases. With the smaller samples sizes, this test applied to the data used in 1968 would yield even *higher* probabilities, while the Chauvenet criterion value would be *less*.

One may ask whether including these specimens among the robust australopithecines is really "biologically abhorrent," as Gutgesell suggests. Surely, one cannot determine this on the basis of statistical tests. Still, there are ways of approaching the

question of whether one would expect the amount of variation indicated in the inclusion. One possibility is to compare ranges of variation in related taxa. Length will be used because in both M_1 and M^3 the length comparisons show the greatest distinctions. It is necessary to calculate the relative length range (range divided by mean expressed as an index) to allow for different mean values. For M_1 , the relative range in robust australopithecines is 38, as is the relative range in gracile australopithecines—the most closely related taxon. The value for *Homo erectus* is 37, and for *Homo sapiens*, 43. M^3 in robust and gracile australopithecines has relative ranges of 47 and 43. *Homo erectus* and *Homo sapiens* values are 50 and 84. The robust australopithecine relative ranges, with “Telanthropus,” are comparable (when not identical) to other hominid ranges. Furthermore, the absolute M_1 range in *Homo sapiens* is almost identical to that of robust australopithecines and is greater for M^3 .

If the “Telanthropus” teeth belong to robust australopithecines, there should be other specimens intermediate or as small. This is the case. The breadth of TM 1536 (11.5 mm) is less than that of SK 15 (11.9 mm). While the lengths are not as close, the age difference between them could easily account for the difference as the result of interstitial wear. On the average, Australian Aborigine first lower molars lose over 2 mm of length over the same age range that exists between SK 15 and TM 1536 (Begg 1964:18–19). In the maxilla, several specimens of M^3 approach SK 80/846/847 in length, and SK 47/99 is actually narrower. Here again, age differences may account for the length difference.

One can only conclude that the procedures and results of my initial dental comparisons are verified on their own basis. Using only those procedures that meet Gutgesell's approval, doubling the sample size of robust australopithecines yielded exactly the same conclusion for both mandibles and the maxilla. Indeed, approaching the whole problem in the manner indicated by Gutgesell by assuming two separate samples and using the statistical test she suggests to compare them leads to exactly the same result whether applied to the data used in this paper or applied to the much smaller sample used in 1968. In all cases, and in all combi-

nations, SK 15, 45, and 80/846/847 cannot be justifiably separated from the robust australopithecines on the basis of tooth size.

Conclusion

Gutgesell has been demonstrated incorrect in most of her factual claims as well as in her statistical procedures and results. Some of these demonstrations were based on the *expected* range of variation in robust australopithecines, inferred from similar ranges in closely related hominoid species. Yet, were most of these demonstrations so based, the results would be ambiguous, depending on inferred information we do not actually have. However, in the *majority* of instances, her statements were invalidated by the *observed* range in robust australopithecines. In fact, some of the stated comparisons were not supported by an examination of variation in the “Telanthropus” specimens themselves.

The major limitation of Gutgesell's paper is the almost exclusive and uncritical use of two sources (Broom and Robinson 1952; Robinson 1953b), the former of which utilizes almost no nonaustralopithecine comparative material while the latter picks the one mandible for use in its comparisons, from all the specimens then available (and *instead of* all the specimens then available), that had undergone the greatest amount of crushing toward the midline (SK 23). At the same time, a major work by Dart (1955), which should have been at least considered, is dismissed in a sentence. In this case, as in so many other instances, Dart was correct in his analysis of these specimens many years before others in the field reached the same conclusions, one might add for the same reasons.

In 1968, I concluded: “Perhaps, if the material were found in another context, the same morphological ambiguities that do not allow its separation from the australopithecines could be used to argue its inclusion in *Homo erectus*” (1968:490). That conclusion is no longer justified. With the additional australopithecine data now available to me and the demonstrated association of the maxilla (SK 80) with a cranium described as “Paranthropus” by both Robinson and Tobias, I have attempted to show that the only possible interpretation of the detailed morphology, the ranges of variation,

and the statistical comparisons is that SK 15, 45, and 80 are small robust australopithecines. If, in the twenty-one years since the taxon "Telanthropus" was named, debate about the included specimens has indicated their close relation in many features to *Homo erectus*, perhaps it is time to reexamine those hypotheses that interpret the robust australopithecines as a taxon specialized in its adaptation and extinct without issue. Such an interpretation does not derive from the single species hypothesis.

Note

¹ I am deeply indebted to C. L. Brace, University of Michigan, for his permission to use data, both photographs and measurements, gathered on the original material and to C. K. Brain for permission to reproduce the Swartkrans Cave line drawing. I thank J. Cadien and G. Wright, Department of Anthropology, as well as G. Northcutt, Department of Anatomy, at Case Western Reserve University for their extensive aid in critically analyzing and accurately interpreting the detailed morphology, variation, and archeology of the robust australopithecines.

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"TELANTHROPUS" AND THE SINGLE SPECIES HYPOTHESIS: A FURTHER COMMENT

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I have been given the opportunity to add some information to the Gutgesell-Wolpoff correspondence. Although I have strong reservations concerning Wolpoff's expansion of the robust australopithecine molar sample, his arguments, together with Le Gros Clark's (1967) discussion and my own observations of the material lead me to the conclusion that the "Telanthropus" fragments are those of an australopithecine. However, I believe the question of single vs. multiple hominid taxa at Swartkrans is still very much subject to continued examination and to the discovery and evaluation of new specimens. I would like to present here some further observations that I believe will be of interest in the present debate.

Wolpoff has pointed out the great range of variability that exists within populations of *Australopithecus africanus* and *A. robustus*. While his arguments center on the statistical examinations of populations, there are to be found individual specimens of each taxa whose morphological characteristics are strikingly similar. The three juvenile mandibles from Swartkrans (SK 25), Sterkfontein (STS 18), and Makapansgat (MLD 2) illustrate this point. The three jaws represent individuals of approximately the same age, between eight and twelve years (Mann 1968). Figure 1 pictures occlusal views of

these mandibles, while Table 1 details their morphological characteristics. There are great similarities both in the size of the teeth and in the dimensions of the mandibular corpus (STS 18 is still within a limestone matrix). Note that SK 25 is assigned to the taxon *A. robustus* while the other two are usually placed within *A. africanus*. It is interesting that although the dimensions of the mandible are not often used in distinguishing the two categories, the differences in the size of the cheek teeth between *A. africanus* and *A. robustus* have figured very prominently in determining taxonomic affinities. All three jaws are extremely similar in those characteristics that can be subjected to measurement, and there is no question that had these three fossils been found in the same geological context, they would have been placed in the same taxonomic category.

The report of Clarke, Howell, and Brain (1970) that the "Telanthropus" maxillary fragment SK 80 has been articulated with the *A. robustus* facial-cranial fragments SK-846/847/848 raises significant questions, which Wolpoff has thoroughly discussed (AA 72:576-607). In their article, they employ several morphological attributes as evidence that the SK 80/847 fossil be included in the genus *Homo*. In general, their evidence is unconvincing. In particular, I am disturbed by their use of the size of the supraorbital torus as a distinguishing character. Tobias (1967:104) provides measurements of the tori of the South African australopithecines, including SK 847. These measurements indicate that there is no difference in torus size between SK 847 and the other South African fossils. Additionally, based on my measurements and examinations, other anatomical considerations used to classify SK 80 as *Homo erectus*—the depth of the palate and the distinct break between the subnasal area and the nasal floor (Robinson 1953)—are clearly visible on the Sterkfontein maxillae STS 52a and STS 53.

Finally, the increased time depths now associated with the East African australopithecines (Howell 1969), and the strong indications that the South African sites may be older than has been previously thought (Cooke, personal communication), suggest that the material from South Africa must be viewed in a new perspective. For example, if